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FARMERS' BULLETIN 419.

Experiment Station Work, LIX.

Compiled from the Publications of the Agricultural Experiment Stations.

TILLAGE v. SOD MULCH IN ORCHARDS.
EAR CHARACTERS OF SEED CORN.
SEED DISINFECTION.
BLACKLEG OF THE IRISH POTATO.
PROGRESS IN HORSE BREEDING.
SWEET POTATOES.

JULY, 1910.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.
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EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

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EXPERIMENT STATION WORK.[a]

TILLAGE VERSUS SOD MULCH IN APPLE ORCHARDS.[b]

Horticultural investigators quite generally agree that clean tillage throughout the whole season is not good orchard practice, since constant clean tillage not only depletes the humus content of soils, thereby causing them to pack and to be unable to retain water in proper quantities, but it is also responsible for considerable soil erosion in hilly sections. Thus the term "tillage" as applied to orchard management has come to mean thorough cultivation of the orchard during the early part of the growing season followed by a cover crop late in the summer, which is in turn plowed under early in the spring, thereby adding an annual supply of humus-forming material to the soil.

With certain modifications to meet regional requirements, tillage as above defined is generally recommended as the best orchard practice. On the other hand, certain orchardists, notably F. P. Vergon, of Ohio, and Grant Hitchings, of New York, have been highly successful in growing apples under the so-called sod or grass-mulch systems of soil management. These men have many supporters, and considerable discussion has arisen as to the relative merits of the tillage and sod-mulch methods of management. It is true, however, as U. P. Hedrick, of the New York Geneva Station, says, that in the discussion which has been going on men for the most part have been citing particular orchards, isolated cases and not principles. "The tillage and the sod methods of managing orchards are so radically different that they can not be equally good. * * * It seems necessary to establish by means of experimental evidence principles that will apply to orchards in general."

At least three of the state stations (Ohio, New York, and Pennsylvania) are conducting long-continued experiments in which the disputed

[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from New York State Sta. Bul. 314; Pennsylvania Sta. Bul. 91; The study of a mulched orchard, by H. W. Collingwood, Rural New Yorker, 68 (1909), Nos. 4017, p. 921; 4018, p. 941; 4019, p. 962; 4020, p. 983; 4022, p. 1022; 4023, p. 1047.

systems of culture are being studied and from which it is hoped that certain fundamental principles may be evolved before the investigations are completed. The average results secured by the Ohio Station during the first six years of their trials have been reported in a previous bulletin of this series.[a] Although these results were markedly in favor of the sod-mulch system of culture, the investigators, Green and Ballou, considered them as preliminary only. They say "the results of investigations * * * were secured under conditions prevailing at the experiment station orchards alone, and it is expressly desired that this record of results be accepted as suggestive rather than conclusive, and as a stimulus to individual fruit growers to pursue this line of study under local and necessarily widely different conditions."[b]

In the attempt to find out whether the apple thrives best under tillage or in sod, the New York Station is conducting two experiments. In a bulletin of that station which appeared during the past year, U. P. Hedrick gave a preliminary report covering a period of five years on one of these experiments. The other experiment has not been carried far enough to be reported on.

The experiment under consideration was begun in 1903, in the orchard of Mr. W. D. Auchter, near Rochester, N. Y. The orchard, which consists of 9½ acres of Baldwin trees, 40 feet apart each way, was about 26 years old, when the experiment was started. The trees had previously been under tillage with an annual cover crop. There are 118 trees in the sod plat and 121 in the tilled plat. The orchard is slightly rolling in topography, with a fertile loam to a depth of 10 inches underlain by a sandy subsoil. Variations in soils are few and slight.

The trees in the two plats received as nearly as possible identical treatment as to pruning, spraying, fertilizing, and all other orchard operations, excepting the system of culture, which was as follows:

Sod plat.—October 15, 1903, 8 quarts each of orchard grass and blue grass seed were sown per acre, from which a fairly good stand was secured. To make sure, however, of a good stand of grass, a second seeding of 16 quarts of blue grass, 8 quarts of orchard grass and 3 quarts of timothy seed was made April 21, 1904. During the first season the grass flora was well divided between the above three grasses, but the second year the orchard grass became dominant and has increased in quantity until now [1909] the plat is covered with an orchard-grass sod. The grass was mowed on the following dates during the five years of the experiment: June 21 and August 23, 1904; June 12 and August 14, 1905; June 18, 1906; June 27, 1907; May 27 and July 4, 1908.

The grass, if allowed to stand until haying time, would produce 2 tons per acre, and when cut twice the crop would exceed this amount. * * * It was in all cases allowed to remain where it fell from the mower, as the roots of the trees spread over the entire orchard area and there was therefore need to mulch the whole area.

[a] U. S. Dept. Agr., Farmers' Bul. 267, p. 23. [b] Ohio Sta. Bul. 171, p. 208.

Tilled plat.—The following is a memorandum of the treatment of the tilled plat:

1904. Plat plowed June 7–11; ground harrowed June 13, June 20, July 19, July 29. Cover crop of mammoth clover sown July 30 and the seed harrowed in with a weeder.

1905. Plat plowed May 30; rolled June 5; harrowed June 13; June 26, July 7, July 22, August 2. Mammoth clover sown August 3 and the seed covered with a weeder, followed by a roller.

1906. Plat plowed June 4–6; rolled and harrowed June 7; harrowed June 22, July 19, August 2. A cover crop of oats was sown August 2 and harrowed in the next day.

1907. Plat plowed May 27–29; land harrowed May 31, June 28, July 17, July 27, August 5. A cover crop of mammoth clover was sown August 6 and covered with a weeder.

1908. Plat plowed May 23–26; land harrowed May 27, June 4, 12, 23, and July 31. A cover crop of oats was sown July 31 and harrowed in the following day with a weeder.

The relative merits of the two methods were gauged by all important characters of fruit and tree. Professor Hedrick summarizes the results for the five years as follows:

The average yield on the sod plat for the five years was 72.9 barrels per acre; for the tilled plat, 109.2 barrels; difference in favor of tilled plat, 36.3 barrels.

Estimates made at blooming and fruiting time showed a far greater number of fruits on the tilled trees. Actual count showed 434 apples per barrel on the sod land weighing 5.01 ounces each. and 309 apples per barrel on the tilled plat weighing 7.04 ounces each.

The fruit from the sod-mulch plat is much more highly colored than that from the tilled plat.

The fruit on the sod-mulch plat matures from one to three weeks earlier than that on the tilled plat.

In common storage, fruit from the tilled plat keeps four weeks longer than that from the sod plat. In cold storage, the keeping quality of the two fruits is the same.

The tilled fruit is decidedly better in quality, being crisper, more juicy, and of better flavor.

The advantage of tillage over the sod-mulch in the matter of uniformity of trees and crops is marked. The trees in sod showed abnormalities in foliage, branches, roots and particularly in fruit-bearing and in fruit characters.

The average gain in diameter of trunk for the trees in sod for the five years was 1.1 inches; for the trees under tillage, 2.1 inches; gain in favor of tillage, 1 inch.

The dark, rich green color of the foliage of the tilled trees indicated that the tilled trees were in the best of health. On the other hand the yellow color of the leaves of the sod trees told at once that something was amiss.

It needed only a glance in the orchard to see that the leaves of the tilled trees were much larger and much more numerous and that therefore the total leaf area was much greater.

Leaves from sodded trees and the same number (2,400) from tilled trees were weighed and gave 8.7 grams as the average weight per leaf for the sodded trees and 11.5 grams for the tilled trees.

The leaves of the tilled trees came out three or four days earlier and remained on the trees a week or ten days later than on the sodded trees.

The average annual growth of branches for the sodded trees was 1.9 inches; for the tilled trees, 4.4 inches. The average number of laterals per branch on the sodded trees was 3.4; on the tilled trees, 6.7.

During the dormant season there was a striking difference in the appearance of the new wood in the two plats. The new wood on the tilled trees was plumper and brighter in color, indicating better health.

The amount of dead wood in the sod-mulch trees was much greater than in the tilled trees.

The roots of the trees in the sod-mulch plat came to the very surface of the ground. How much these trees suffered by the destruction of roots in the heat and drought of summer or the cold of winter can not be said. In the tilled land the roots were found in greatest abundance at a depth of from 3 to 10 inches.

The circumference of the root systems in the tilled trees is approximately circular, but the circumference of the roots of the trees in sod is very irregular, indicating a reaching out of a part of the roots in response to a demand for more moisture, food, or air, or to escape some evil effect of the grass roots.

A fair way of comparing the quantity of the living roots of the trees in the two plats could not be found.

The trees in the outside rows of the sod plat, where the roots could penetrate into the tilled land, without exception showed better health and greater productivity than the trees in the inner rows.

The average cost per acre for the two methods of management, not including harvesting, was $17.92 for the sod, and $24.47 for tillage, giving a difference of $6.55 in favor of the sod. The average net income per acre for the sod plat was $71.52; for the tilled plat, $110.43, a difference of $38.91 in favor of tillage, an increase of 54 per cent for tillage over the sod-mulch method of management.

Upon analyzing the data secured in the work, Professor Hedrick finds that the tilled plat was superior to the sod plat for a number of reasons, chief of which is that the tilled soil contained more moisture and consequently furnished a better medium for rendering food available to the tree. The tilled soil also contained more humus and was from 1 to 2 degrees warmer than the sod land. It is also pointed out that tilled soils are better aerated than sodded land and contain a greater number of beneficial micro-organisms.

As to the positive injurious effects of grass on apples, Professor Hedrick calls attention to the possible toxic effect of the grass roots but in lieu of further evidence along this line he prefers to attribute the injurious action to disturbances of plant nutrition. Analyses made in 1908 show that the soils in the two plats varied only slightly as to the amounts of the several plant foods.

If lack of food is the cause of the deleterious effect of the sod on the trees it is starvation in the midst of abundance. The food is in the soil, but because of a lack of water to bring it into solution, or because the soluble fertility is monopolized by the grass, the trees do not get it. The fact that the grass does not seemingly suffer suggests that the grass roots surround the tree roots and have the first opportunity to take moisture and food and leave but little for the rootlets of the trees.

The last consideration suggests that in deep, fertile soils, where the tree roots may go down and escape the grass roots, competition between the two plants may be less strenuous and the effects of the grass on the apple therefore less harmful than in the comparatively shallow soil of the Auchter orchard. The data, secured from a number of orchardists, show that the orchard soils of New York are shallow. In 333 orchards out of 528 in this State the top-soil is not over 12 inches deep. The average depth of the top-soil in the Auchter orchard is, as we have seen, from 9 to 12 inches. Since the rooting habits of trees are very different, sod may be more harmful to some varieties than to others. * * * The experiment does not show that apples can

not be grown in sod. There are many orchards in New York which would prove the contrary. It suggests, however, that apples thrive in sod, not because of the sod, but in spite of it. The fact that there are many thrifty orchards in sod in New York is not proof that these orchards would not do better under tillage.

In considering the two methods of management, of all the factors affecting the growth of trees in this experiment, conservation of moisture should receive first attention from the apple grower. This statement is affirmed not only by the results in the Auchter orchard but in practice the world over. The climate of Europe is moist; sod orchards are the rule there. Near the Atlantic seaboard in America, as in New England, where the rainfall is comparatively high, thrifty orchards are found in sod. In the western fruit regions, where irrigation is practiced, sod orchards are hardly to be found; water is purchased and must be conserved. In irrigated lands tillage is found to be the best means of moisture conservation. Moisture is by no means the only factor to be considered in the controversy over the sod and tillage methods of management, but it appears to be the chief one.

The experiment being conducted by J. P. Stewart at the Pennsylvania Station was not started until 1907 and no definite results can be expected for some time. As determined by the yields for two years, however, the results indicate that a sod-mulch treatment, which in this case consists of an annual mulch of straw at the rate of 3 tons per acre in addition to the grass left in the orchard, "is of value in developing and establishing the bearing habit in orchards which have reached the bearing size and age," and that with mature orchards tillage is to be preferred.

The other experiment, which the New York Station is conducting, is located on the Hitchings farm, where the sod-mulch system has been so successfully employed. This experiment should be of particular value in showing why Mr. Hitchings has so successfully grown his orchards in sod.

In the light of present knowledge, however, it would seem that a successfully grown sod-mulch orchard is the exception. To those who believe their soil is sufficiently moist and deep to grow their trees in sod, the following remarks of H. W. Collingwood, who recently conducted a critical study of the Hitchings orchards, should prove of some value.[a]

I can see only one reason why Mr. Hitchings should want to plow in order to improve the trees. They are satisfactory in their performance and promise as they stand. The most serious objection I have found to this sod culture is the danger from fire. Should fire start on a dry, windy day, say in spring, before the new growth starts, the work of years would be quickly wiped out. I know this, because fire swept through my own orchard and ruined several hundred young trees. That is the weak point in a mulched orchard and it is a serious problem. Near a railroad or where careless hunters roam a mulched orchard without fire protection for the trees is always in danger when the grass is dry. We plow a wide strip around the orchard to keep out running fires, and in some exposed places plow strips along the rows. * * * The fire peril is the most serious objection to mulching that I have found. * * * Of one thing I am sure—any man who thinks he can produce another Hitchings orchard

[a] Rural New Yorker, 68 (1909), No. 4023, p. 1047.

without leaving everything that grows except the apples, and hauling in other mulching material also, will fail eight times in ten.

EAR CHARACTERS OF SEED CORN IN RELATION TO YIELD.[a]

The main purpose of seed corn selection is to increase the yield of shelled corn per acre.[b] It is of first importance then to know what ascertainable characters indicate the most productive ear. The average man can not select his seed corn with the aid of a chemical laboratory and does not know its pedigree, although he may keep his own breeding plats and increase fields. He should see the mother plants and the surroundings from which his seed ears have come. Field selection enables him to do this, but its complete success demands knowledge of the conditions of growth most likely to give seed vigor and prolificacy and a keen appreciation of the ear characters that indicate seed of great yielding power. Which will produce the more corn per acre, the long ear or the short ear, the light ear or the heavy ear, the one with the bare tip or with the well-filled tip, the one with a high or low shelling percentage, with a tapering or cylindrical shape, with rough or smooth indentation? Since few ears are strong in every point, which is to be the most sought for, the good butt or a good tip, a good kernel or a symmetrical ear? These and similar questions the score card undertakes to answer, but it indicates what is good corn rather than what ears will produce greatest yield when planted. Its standards are those of the market rather than those of the farm, although an effort is made to avoid this by assigning great weight to points indicating high germinating power. The ear having the greatest weight, symmetry, and shelling percentage will not necessarily produce the highest yield when planted. Score card standards and values are only estimates at best. An attempt is being made to answer the same questions by careful trials at the Ohio Agricultural Experiment Station. The relation of shape of ear, filling of tip, indentation of the kernel, weight of ear, and environment of the parent plants to the yielding power of seed corn are being tested in experiments that have already been conducted for four or five years.

During the period 1905–1909, long ears produced higher yields than short ears in 21 out of 22 tests (see fig. 1), the average difference in yield being 3.97 bushels per acre. In 1909, 5 varieties were tested and the long ears invariably led in yield by amounts ranging from 2.53 to 6.77 bushels per acre for the different varieties, the average difference being 5.18 bushels per acre and the average difference in

[a] Compiled from Ohio Sta. Bul. 212; Circ. 71.

[b] Various phases of corn breeding have been fully dealt with in previous articles. See U. S. Dept. Agr., Farmers' Buls. 210, p. 11; 267, p. 5; 366, p. 10.

length of seed ears 2.2 inches. The greatest increase in yield is observed in the group where the greatest difference of length of the long and short ears is found, while the least increase in yield comes in the group where there is the least difference in length. The low-yielding short ears invariably exceeded the long ears in circumference, so that it would seem impossible to increase the yield of the short ears by increasing their circumference to balance their lack in weight, if weight should prove to be an important factor in increasing the yield. In case of two of the varieties tested the average weight of the long ears planted was exactly equal. The advantage in yield due to superior length was 4.24 bushels per acre greater in case of the variety having the greater difference in length between its long and short ears. Although the longer ears outyield the shorter there is no evidence that selection for extremely long ears increases the yield above those of medium length. The difference in yield seems to result from a less-

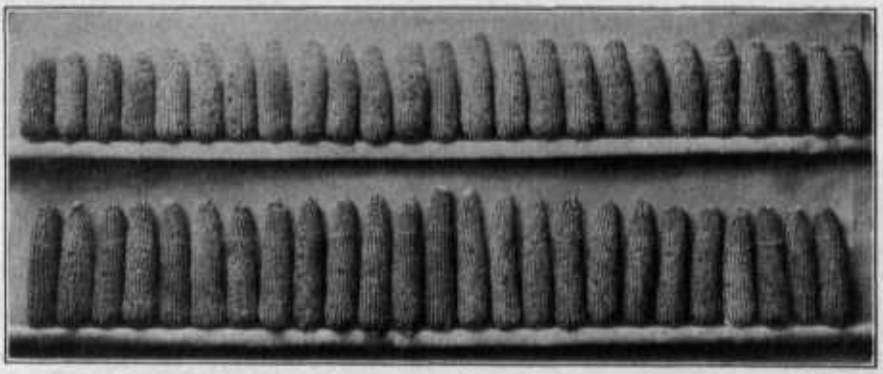

FIG. 1.—Long and short ears of Leaming corn.

ened yield due to selection for short ears rather than to an increased yield from the selection for long ears.

In the study of the relation of shape of ear to yield, 18 tests have been made, and during the first and third years the cylindrical ears led slightly in yield, while during the second and fourth years the tapering ears led. The combined average shows a difference of 0.87 bushel per acre in favor of the tapering ears. In 1909 each of 4 varieties tested showed a gain for cylindrical ears, but Reid Yellow Dent was the only variety in which the variation in yield was of any importance, the average difference being 1.08 bushels. (See fig. 2.)

From ears of Clarage corn having ¾ to 1½ inches of bare cob at the tip and others completely filled (see fig. 3), it appeared that while the bare-tipped ears yielded 0.42 bushel per acre more than those with well-filled tips the first year, continued selection of well-tipped ears from well-tipped parents showed an advantage of 1.45 bushels

per acre in the second year and of 2.19 bushels per acre in the third year for corn grown from well-tipped ears. In the three years of the test 3.7 per cent of the ears produced from bare-tipped seed ears had completely filled tips, as compared with 20 per cent from the filled-tipped seed ears. The average length per ear of bare tips in the harvest from the bare-tipped seed ears was 1.03 inches as compared with 0.53 for the harvest from the filled-tipped seed ears. The crop from the bare-tipped ears has an advantage in length of ears of 0.18 inch, but if the bare portion of the ear is omitted from consideration the progeny of the well-tipped ears had an advantage of 0.32 inch in length. The continued selection of ears having ¾ to 1½ inches of bare cob at the tip tends to reproduce ears of this character and to reduce the percentage of ears having filled tips and to decrease the yield.

During five years ear-row tests of seed ears of the crease-dented type produced an average yield of 2.84 bushels per acre greater than

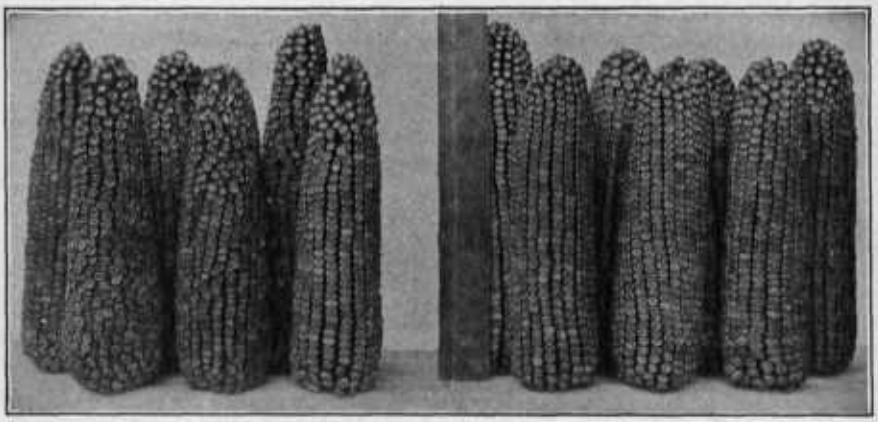

FIG. 2.—Cylindrical and tapering ears of Leaming corn, compared with a 10-inch ruler.

that produced by rough-dented ears. During one year of plat work, the rough-dented ears showed an advantage of 1 bushel and during the second year the crease-dented ears had an advantage of 2.17 bushels per acre in yield. The crease-dented ears used during the last year in plat work averaged 1.2 ounces lighter, 0.2 inch shorter, 0.5 inch less in circumference, and 3.5 less in shelling percentage. While some of these characters taken singly tend to produce an increase in yield they were insufficient to overcome the differences in indentation.

The heavier seed ears may usually be depended upon to give higher yields. Total weight of ear appears to be a better guide to productive power than weight of shelled corn, provided this weight is due to a reasonable length, circumference, and amount and density

of grain and cob, and does not occur in a large immature ear. During three years' ear-row tests, ears having an average advantage of 2.06 ounces in weight produced yields 5.9 bushels per acre greater than did the lighter ears. Of 400 ears tested, the heaviest 40 per cent exceeded in average weight the lightest 40 per cent by 2.46 ounces per ear and produced a yield greater by 2.08 bushels per acre. In plat tests, 50 heavy seed ears yielded at the rate of 0.63 bushel per acre more during the first year and 3.23 during the second year than did the lighter ears. Of the same 400 seed ears, the 40 per cent having the highest shelling percentage produced average yields 1.2 bushels lower than the 40 per cent having the lowest shelling percentage. The shelling percentage of the harvest was 4.2 per cent in favor of that from the seed ears having the higher shelling percentage. Among 200 ears the 20 having the lowest shelling percentage ex-

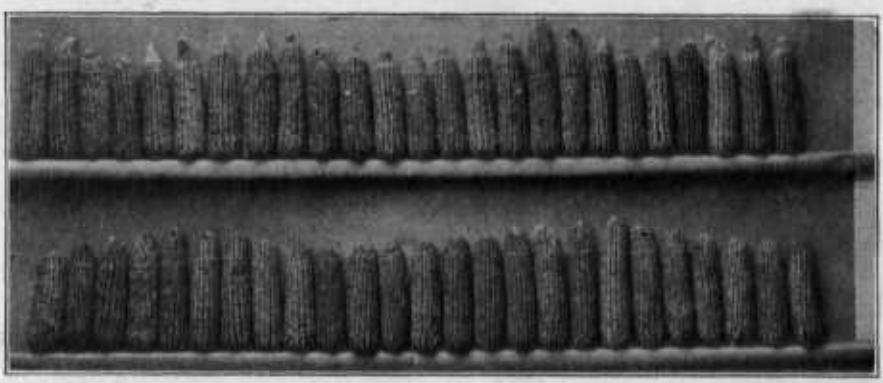

FIG. 3.—Filled and bare-tipped ears of Clarage corn.

celled the 20 having the highest by 6.42 in shelling percentage and by 3.57 bushels per acre in yield.

In the selection of seed the environment of the mother plants should be considered. As ordinarily selected from the shock, wagon, or crib, most of the ears are probably excellent because they grew under favorable surroundings. Their superiority is probably due to the fact that the mother plant received the food, sunlight, and moisture intended for several plants. Field selection will avoid a part of this difficulty, as it is well known that seed produced under such favorable circumstances is less vigorous under unfavorable conditions. Seed selected from the plant has been found to yield an average of 3.23 bushels per acre more than that selected from the wagon but grown in the same field. The ears selected from the wagon were superior in size and general appearance but the environment in which they were produced was of course not definitely known. The time of maturity of the ear, number of ears per plant, the fertility of the soil,

the proximity of barren stalks, and the number of plants in the hill should be considered, as should also the vigor of the plant and its abilty to stand upright. This ability does not result entirely from a lighter load, for an ear which yielded 75.6 bushels per acre produced plants only 44 per cent of which stood upright, while another ear yielding 114.7 bushels per acre produced plants every one of which remained standing. Seed corn from a highly manured plat in 1907 produced 0.98 bushel less corn per acre than did that from a plat which had remained unfertilized for sixteen years, and in 1908, 2.32 bushels more, while in 1909, the seed from the unfertilized plat led in yield by 3.8 bushels. Ears selected from stalks grown in normal stand produced in a four years' test an average of 2.36 bushels more

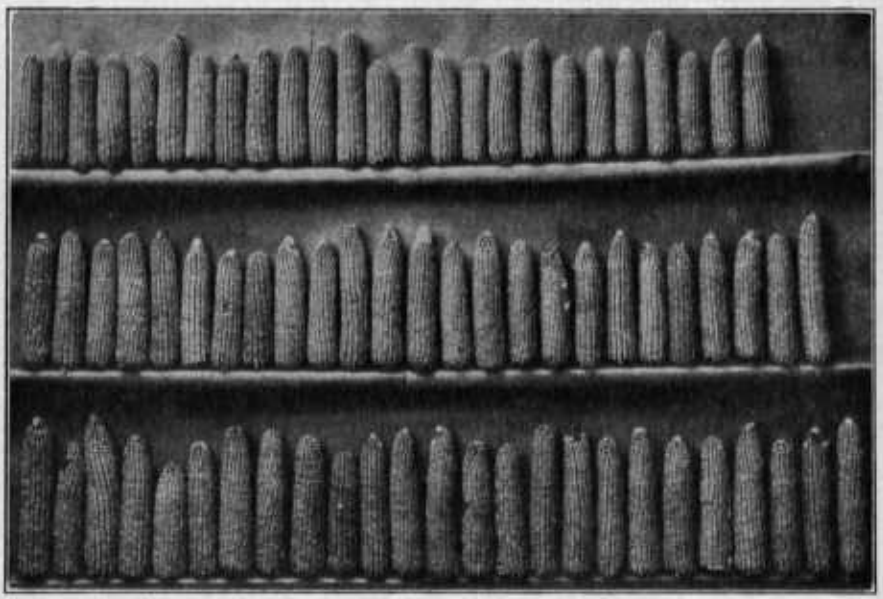

FIG. 4.—One, three, and five plant strains of Clarage corn. One plant strain at top.

per acre than did ears selected from the wagon and without any knowledge of the stand. Seed selected from plats planted at rates of 1, 3, and 5 plants per hill produced yields of 91.49, 91.74 (see fig. 4), and 92.58 bushels per acre, respectively. While these differences are slight they indicate that seed ears inferior in size and appearance because of environment may be superior in hereditary value.

Undue dependence is often placed upon the germination test which will at best indicate only which ears will grow and which will not. From 600 ears germinated under 1 inch of soil those first up produced an average yield of 2.84 bushels less than those which came up last. They probably contained a larger proportion

of white starch, which absorbed water more rapidly, and so caused more rapid germination. The 40 per cent of the ears showing the best germination test produced an average yield of 0.68 bushel per acre greater than the 40 per cent showing the poorest germination, but in this test only those ears were considered of which every kernel planted grew. A new variety should not be discarded because it fails to excel native varieties during the first year of its test in the new locality. A longer period of continuous selection is necessary to determine its real value when fully adjusted to local conditions and to eliminate those strains which are not suited to the new locality.

Although these tests are regarded by the experimenters as unfinished and were made with a limited number of varieties and in one locality only, they appear to indicate (1) that the selection of seed ears of a length less than normal for a given variety or locality will reduce the yield and shorten the length of the ear; (2) that tapering ears produce slightly higher average yields than cylindrical ears; (3) that continuous selection of ears having 1 to 1½ inches of bare cob at the tip will increase the average amount of bare cob and decrease the yield of shelled corn; (4) that crease-dented ears are superior to rough-dented ears; (5) that weight of seed ears is an important factor in rate of yield; (6) that seed should be selected from an environment slightly less favorable than that in which it is to be grown; (7) that the germination test is not an index of hereditary merit; and (8) that introduced varieties should be adjusted to local conditions by careful and continued selection.

SEED DISINFECTION AND CROP PRODUCTION.[a]

As H. L. Bolley states in a recent bulletin of the North Dakota station—

> It is now a well-known fact that many very destructive diseases of farm crops are introduced by way of the seed. It is also a well-understood fact that there are various methods of treating the seed grain, which more or less successfully control the action of any diseases which are introduced by way of the seed.

Professor Bolley describes the general characteristics of a few of the more important diseases of wheat, oats, and other cereals (including flax) to which he has given particular attention, and gives a simple statement of the best methods and appliances now known for the prevention or control of seed-borne diseases. He shows that "the essential work involved is to treat the seed grain so as to destroy the vitality of the spores or filaments of the various parasitic plants which cling as dust on the exterior or within the covering of the seed coats, without injury to the germination powers of the grain

[a] Compiled from North Dakota Sta. Bul. 87.

and to indicate that this can be successfully done in various ways and with various substances as disinfecting agents."

His recommendations as applied especially to North Dakota conditions are, in brief, as follows:

For stinking smut of wheat.—(1) Use formaldehyde at the rate of 1 pound (16 ounces avoirdupois) to each 45 gallons of water. (2) Clean and grade the wheat so as to remove the smut balls and light-weight kernels. A powerful nearly vertical wind blast is best for this purpose. (3) Wet the grain in any manner most convenient to the operator, by dipping machines, sprinkling and shoveling, or by means of a powerful misty spray while the grain is being rapidly hoed, raked, or shoveled over. The essential feature of the work is that each and every grain shall be evenly moist over its entire exterior. (4) Do not use any more of the solution than necessary to accomplish the even moistening recommended. In any case three-fourths gallon to 1 gallon of solution is a fair estimate for use upon each bushel of dry wheat. (5) Sow the grain as soon after treatment as possible, while yet damp and swollen; the yield will be better and the treatment more certain of complete prevention of smut and other diseases. (6) It is usually convenient to treat in the morning for afternoon sowing and in the afternoon for morning sowing, though in the larger farms the treatment goes on continuously and the sowing continuously, the grain being taken direct from the large smut mills to the grain drills. (7) Set the drill to sow the proper amount of swollen grain. This amount can readily be ascertained by experiment in a few rounds of the drill and by also taking note of the amount of original dry grain and ascertaining what the increased measure is by swelling. Ordinarily if sown at once the drill should be set to sow 1½ bushels of wheat if it is desired that it should actually carry the number of seeds per acre represented by 1¼ bushels of dry grain. However, each individual method of treatment will cause the amount of swelling to vary somewhat, and different drills work somewhat differently with wet grain. (8) People who do not feel sure that it pays to disinfect seed wheat or any other seed grain should try an untreated strip alongside of the treated field.

Loose smut of wheat and barley.—The formaldehyde treatment as given for stinking smut of wheat, though beneficial in the treatment of loose smut of wheat and barley, is not wholly effective against these. Those who wish as nearly as possible to prevent these diseases should resort to the development of the seed plat, upon which sufficient seed may be raised comparatively free from these diseases to be used for the general wheat or barley crop. The seed for this plat should be treated as recommended in the modified hot-water treatment.

This treatment consists of soaking the seed for 5 to 7 hours in cold water, followed by immersion in water at 129½° F. for 10 minutes in case of wheat, and in cold water for 5 to 7 hours and in water at 125½° for 15 minutes in case of barley.

Locate the seed plat as distant as possible from general field crops of similar grain and upon land not recently cropped to that grain. Thrash the grain in a clean machine and store in a clean bin or clean bags. As the loose smuts of barley and wheat show their black heads early, before most of the other heads form, it is easy to go through the field and pull up the stools thus attacked. They are quite as easy to find as mustard blossoms. If any heads develop in the seed plat, these should be pulled, bagged, and burned before the smut begins to blow about. Cooperative work by the farmers of a given neighborhood will be essential in order to fully rid the lands of these types of smuts.

Corn smut.—This is a type of smut that accumulates in the soil with considerable rapidity as crop of corn follows corn in the neighborhood. The spores blew from stalk to stalk and from the wind-blown spores of old smut masses of the previous year.

The preferable method of controlling this disease is by cutting the smut masses while they are young and collecting and burning them before the spores can be distributed.

Oat smut.—(1) Use the formaldehyde solution in the same strength as recommended for wheat, and by any of the methods of wetting the seed found to be most convenient. When properly handled some of the smut mills or dipping machines are very efficient. (2) Grade the oats thoroughly so as to blow out all smut masses and light-weight grains. (3) Wet the grain so thoroughly that the solution may gain access to the inside of the chaff scales. The oats should remain piled from two to three hours, to allow the moisture to penetrate. The writer prefers to wet the oats sufficiently to cause them to swell, and then at the end of two hours follow this by a second wetting, a process which insures effective moistening of all of the spores. It is to be remembered that formaldehyde fumes do not kill smut spores unless the smut spores are wet.

Each man's treatment will cause a different amount of swelling of the grain, and the drill should be set accordingly to cause the proper amount of seeding. If the work is well done, 2 bushels of dry grain will equal approximately 2½ bushels after the treatment. Do not allow the grain to dry out before sowing.

Millet smut.—Use the same treatment and the same methods as with oats.

Flax wilt and flax canker.—(1) Select only plump, bright-colored flaxseed for sowing purposes. (2) Fan and grade this seed until all light-weight seeds and all bits of chaff and straw and dirt particles are removed, for these carry the disease internally and can not be sufficiently wet to destroy the parasites. (3) Place a measured quantity of seed, say 5, 10, 15, 20, or 30 bushels, upon a canvas or tight floor. (4) Use formaldehyde solution at the rate of 1 pound to 40 gallons of water. (5) While one person rapidly rakes or shovels over the grain, put on the solution in the form of a fine misty spray. A compressed-air sprayer is essential for this work. Dry flaxseed, when treated in this manner, will easily absorb one-half a gallon of solution for each measured bushel. Indeed, if the shoveling and raking is sufficient, two-thirds of a gallon may be used without causing matting. When the work is sufficiently done the seed will look befogged or thoroughly moist. (6) Leave the grain piled, covered by blankets or canvas, from two to three hours, after which it may be shoveled over and then it is ready for seeding. (7) Seed such treated flax upon land that has not previously grown flax for a number of years, preferably five or six years. (8) Cease sowing flax consecutively upon the same land. (9) Introduce as long a series of rotations as possible, especially ones which include a cultivated crop, such as corn. This care with regard to rotation with reference to the flax crop is essential, because the flax diseases are of such nature that they propagate and spread through the soil after the manner characteristic of potato scab. These diseases especially develop upon the masses of flax stubble and roots. The aim of the rotation is to allow this food material for the flax parasites to decompose and disappear. The chief aim of the treatment is to prevent the introduction by way of the seed of new points of infection in the soil. It does this quite effectively and at the same time insures the treated crop against disease, provided the soil upon which the seeds are sown is not already diseased. (10) Those who have their entire farm flax-sick should practice growing their own seed, for eventually if what they save from such flax-sick soil is properly graded the seed thus obtained will each year grow more and more resistant to wilt.

Yeasts, molds, blights, rots, etc.—There is no class of garden, forage, or cereal crops the seed of which may not be injured at germination time by the presence of ordinary molds, bacteria, and ordinary yeast fungi. Grass seeds, clovers, alfalfa, corn, onions, beets, etc., are all benefited by being disinfected before planting. The formaldehyde solution as recommended for wheat and oats is the most efficient seed disinfectant known for such purposes. Seed corn, especially, is highly benefited by the treatment. Ordinary yeasts, molds, and bacteria which are in no way capable of producing a disease of the corn plant itself produce great harm to the seedling by bringing about

molding and fermentation of the food materials stored in the mother seed. If the growth season is cold and backward, disinfected seed does not ferment and decay as rapidly as seed which has not been properly treated. On the untreated seed all sorts of molds and decay fungi at once start up fermentation of the stored food materials and the products formed are poisonous to the young plant.

Root-rots and blights of wheat.—New studies conducted by this Department have demonstrated the fact that the wheat crops are quite commonly attacked by three or four types of minute fungi not heretofore recognized as definite wheat parasites. These parasites not only attack the wheat heads and grains but gain entrance to the interior of the grain and bring about blighting and shriveling, and also live over in the soil after the manner characteristic of flax-wilt and flax-canker fungi. It is therefore important that seed treatment and rotation of crops be followed for exactly the same reason as given for the prevention of the diseases of flax. As the wheat crop is much more general in its distribution than flax, it will be more difficult to gain as definite results.

Treatment.—(1) Obtain home-grown seed of pure variety. (2) Select the brightest, plumpest, and heaviest type of berry possible. (3) Grade this grain by means of a heavy wind blast, preferably vertical, in such manner as to eliminate the light-weight shriveled kernels. Treat the seed as recommended for smuts of wheat, either by the formaldehyde method or the modified hot-water method. As these diseases of wheat often attack the grains internally, it is possible that some new method of seed treatment will yet supplant ones now in common use, though these are extremely efficient. (4) Sow the treated grain upon soil that has not lately been occupied by wheat. The rotation should be of such nature as to introduce one or more thorough cultivations of the soil, such as that necessary to develop a proper corn or potato crop. (5) In fertilizing land which is to be sown to wheat, use thoroughly composted manure, that the diseases which are resident upon the wheat straw commonly used in animal bedding may be killed by the composting process.

BLACKLEG OF THE IRISH POTATO.[a]

In a recent bulletin of the Maine Station Prof. W. J. Morse gives an account of this disease from which the following statement is condensed:

Blackleg is a bacterial disease of the stems and tubers of the potato, probably introduced into Canada from England and from there into the United States. It occurs, to some extent at least, over a considerable area of the potato-growing sections in the eastern United States and Canada. A similar disease is also found in England, Germany, France, and other parts of Europe. It has been reported from Charleston, S. C., Norfolk, Portsmouth, and several points on the eastern shore of Virginia; Beltsville, Md., Long Island, N. Y., Gurley, Colo., and Plainesville, Ohio. It is probably in Oregon, and is apparently becoming widely distributed throughout much of the potato-growing areas of the United States.

As a rule, the plants first show signs of the disease when they are 6 to 8 inches high and growing rapidly. Very moist, cloudy weather favors its progress, resulting in the early death of the young plants

[a] Compiled from Maine Sta. Bul. 174.

within a period of four to six weeks, while dry weather may check its progress.

The attacked plants are usually unthrifty, light green in color, or even yellow, and undersized. The branches and leaves have a tendency to grow upward, forming a rather compact top, often with the young leaves curled and folded up along the midrib. The most characteristic symptom is the inky black discoloration of the stem at or below the surface of the ground. This discoloration often extends 2 or 3 inches above the surface, and the invaded tissues show a soft, wet decay during the active progress of the disease. Usually the seed tubers attached to affected stems are entirely decayed by a soft rot. Occasionally, when the disease makes slow progress on account of dry weather, new shoots may put out above the infected region, bearing many small potatoes, even to the extent of producing small green tubers upon the stem above the ground. Infection of the growing plants always begins below the ground, usually at the junction of the stem with the diseased seed piece. The germs of the disease are capable of causing a rapid decay of the young tubers, and these are sometimes attacked also.

It seems that the blackleg is largely distributed by means of germs in the wounds, cracks, and decayed areas of the seed tubers. The propagation and spread of the disease can probably be controlled by the selection of seed from fields free from the disease, the rejection of all seed tubers which have wounds, cracks, or decayed areas, and by treating the remainder with corrosive sublimate or formaldehyde solution, or with formaldehyde gas, as is done for potato scab.

It is not known whether the disease germs will remain alive in the soil to infect future crops of potatoes or not, but as a precautionary measure the land on which the disease occurs should be kept in grass, clover, or cereals for as long a time as possible before planting with potatoes again.

In no region has this disease done much damage as yet, although it may become a serious pest in some sections, and potato growers should therefore be on their guard against its introduction into new areas or its further dissemination in regions already known to be infected.

PROGRESS IN HORSE BREEDING.[a]

No great progress can be made in breeding animals of any species so long as the breeding stock consists of unsound individuals or is of unknown breeding. The country is overrun with grade and scrub stock of all kinds, and in the breeding of horses there has been much

[a] Compiled from Wisconsin Sta. Buls. 127, 141, 155, 158, 169, 186, 188; U. S. Dept. Agr., Bur. Anim. Indus. Circs. 124, 137.

fraud concerning age, quality, and breeding of sires allowed to stand for public service. A definite plan for breeding operations has been lacking. Some farmers have attempted to improve their stock by grading up with pure-bred sires, but oftentimes unsuitable types have been used and all sorts of crosses have been made. The result has been unsatisfactory.

The advantages of pure-bred stock from a business point of view are discussed by Dr. A. S. Alexander, of the Wisconsin Station, as follows:

> As a business proposition, it pays best to breed mares to pure-bred stallions, although the service fees of such horses are higher than those of the grade or mongrel and scrub. The fees of the latter are $5 to $10 less at the time of service, but when the colt reaches market age the saving is lost. There is at that time a difference of at least $100 in value in favor of the colt from the pure-bred sire, so that the higher service fee has proved a profitable investment. Then, too, there is a ready, appreciative outside market for the good grade colt, while the scrub goes to the local buyer at low figures and there is little, if any, demand for such horses. * * *
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> While some farmers are beginning to appreciate the importance of using sound, pure-bred stallions, the equal importance of using sound mares is not yet generally understood. When a mare by reason of unsoundness no longer is fit for anything else she often is set aside for breeding purposes, and so long as this absurd and ruinous policy persists the penalty will be paid in the prevalence of unsound horses on our farms. For corroboration of what has been asserted here, one has only to examine the brood mares on a number of farms in different districts of the State. The unsound mares will be found numerous and many of their adult offspring are similarly affected. * * *
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> The success achieved in the breeding of Clydesdale horses in Canada serves as a good example of what can be accomplished by persistency and expert selection. The Scottish element of the Dominion's population has been partial to the Clydesdale breed and conversant with its good qualities and utility, hence imported Clydesdale stallions of the best character have been largely employed in the breeding operations of that country since the year 1842. Practically speaking, no alien crosses have been made, and the average farmer has been capable of selecting suitable mares and of adequately developing their progeny. The result is that Canada has but one type of draft horses, and it is a good one, showing, to a high degree of excellence, all of the breed characteristics of the pure-bred Clydesdale. * * * The same thing is true, to an even greater degree, in Scotland, where the Clydesdale breed predominates and has been developed to a high state of purity, breed character, and utility. On the contrary, if we examine the average team horses of Milwaukee or Chicago, we shall see every possible type and character represented and plain evidences of mixed breeding, careless selection, and incomplete nutrition.

By gradual processes the farming communities of European countries have replaced their scrub stallions with pure-bred sires. They have learned by experience that the greatest profits are to be gained by the production of pure-bred and high-grade stock, and in many breeding centers they will not keep or patronize a nonregistered sire. The various governments and national and local breeding associations have aided greatly in the work of eliminating unsound, unsuitable breeding stock. In breeding centers registered mares are to be

found at work in the fields that are mated with inspected, pure-bred stallions. In Great Britain practically all farmers recognize the importance of using pure-bred sires, and only such are used in various districts whence come the many well-known British breeds of horses. In Scotland only one nonregistered stallion has been reported as being used for public service in that country since 1900.

The French Government for over 100 years has maintained stables of carefully selected, sound, pure-bred stallions for breeding purposes.

The best stallions in France are annually chosen for use in the studs, and since 1885, when a government decree to that effect was promulgated, all stallions not coming within special classes have been excluded from public service. The classes referred to are selected by government veterinarians who inspect all horses and grade them as follows: "Subsidized" class, comprising stallions of a certain standard and for each of which a cash bonus of from $60 to $100 per year is paid to the owner to keep the animal in the country for use by owners of mares; "authorized" class, comprising horses of slightly lower quality that are authorized, after passing inspection, by a card certifying them as recommended by the Government for use as sires; "approved" class, comprising a few horses permitted to stand for service, but not granted a bonus or recommendation card.

In Belgium the Government has, since 1850, maintained a great horse-breeding establishment and promotes the breeding of pure-bred Belgian draft horses (Le Cheval de trait Belge) by an annual grant of $5,000 to the official draft horse registration society, and an annual appropriation of $70,000 to encourage the horse breeding of the country. Liberal prizes are awarded to mares and foals at shows throughout the country; stallions are officially examined by government experts; and both approved stallions and mares are granted "maintenance" bounties to retain them in Belgium. Under such auspices horse breeding is making wonderful progress and only pure-bred stallions are in use for service.

In Germany government supervision of horse breeding has obtained for centuries and to-day is similar to that in vogue in Belgium, it having been required by law "that no permits should be issued authorizing the use of stallions, unless they passed a satisfactory government inspection." At the present time both the Government and agricultural societies promote intelligent horse breeding. Prizes are awarded for animals of special merit, and such animals must remain in the country for a specified term. First prizes are awarded only to mature horses and mares that have shown merit as breeders. Stallion shows have long been held at Aurich in East Friesland, where the horses are brought annually for inspection and approval. Prizes for brood mares are also awarded by the Government. Somewhat similar supervision of horse-breeding matters is undertaken by the Government of Austria and large sums of money are annually devoted to the encouragement of the breeding industry.

In Austria there are two state studs and several stallion depots maintained by the Government, and about $1,000,000 is annually expended by the Government in the encouragement of the horse-breeding industry.

The points required by the standard breeding associations oftentimes have nothing to do with the utility of the animal. In order to break away from some of these artificial requirements and in order to preserve and further improve some of the better native types of horses, the Department of Agriculture has undertaken cooperative

experiments with some of the state stations, which promise to be of value to the American stockman. For several years experiments have been under way at the Colorado Station in breeding American carriage horses. At the Iowa Station an experiment is in progress to develop an American type of draft horse. In Vermont a farm of 400 acres is devoted exclusively to cooperative work in breeding horses with Morgan blood, preserving the type and increasing the size. In this cooperative work of the Department the individuality of the horse is the point given greatest weight in his selection, and strict selection to type is the policy in view. Wherever possible inheritance of type has been combined with the selection of type in the individual.

That there is a growing demand for American bred horses is shown by the constantly growing demand, notwithstanding the continual rise in price. To meet this demand Doctor Alexander advocates a campaign for better breeding which involves the following:

Grading up with sound muscular sires; continuous use of pure-bred stallions of a chosen breed; use of sound stallions and mares only; proper feeding and care of the mare and foal; working of stallions regularly; home production of pure-bred stallions to replace grades, mongrels, and scrubs used at present; use of grade horses to replace scrub horses in farm teams; organization of community associations for promoting horse breeding; and the encouragement of the industry by prizes at county fairs for pure-bred stallions and mares and the progeny of these animals.

SWEET POTATOES AND THEIR PREPARATION FOR THE TABLE.[a]

Various questions which have to do with sweet potatoes have been studied at agricultural experiment stations in States where this crop is an important one and valuable data have been accumulated regarding varieties, methods of cultivation, the importance of sweet potatoes as food for man and domestic animals, and their use for starch making and other purposes.

The food value of the sweet potato has received attention in connection with the nutrition investigations of the Office of Experiment Stations, and data regarding the nutritive value, digestibility, and other topics have been discussed in comparison with similar food products in a Farmers' Bulletin[b] dealing with potatoes and other root crops used as food. In a Department publication[c] dealing with the general question of the sweet-potato industry, information was summarized regarding different methods of preparing this vegetable for the table.

As regards its general composition, the sweet potato differs from the ordinary white or Irish potato chiefly in possessing a little less

[a] Compiled from Alabama Tuskegee Sta. Bul. 17; South Carolina Sta. Bul. 146.
[b] U. S. Dept. Agr., Farmers' Bul. 295.
[c] U. S. Dept. Agr., Farmers' Bul. 129.

water and protein and considerably more carbohydrates (starches and sugars). A more important difference is found in the nature of the carbohydrates, sweet potatoes containing considerable quantities of sugar as well as starch, while starch is the characteristic carbohydrate of white potatoes. The proportion of sugar varies with different varieties, the very sweet sirupy yams being the more popular in certain regions of the South and the drier starchy potatoes in the northern markets. The South Carolina Experiment Station has recently reported the results of extensive work on the starch content of sweet potatoes of different varieties, and has shown that the drier the potato the higher the starch content.

When sweet potatoes are prepared for the table about 20 per cent of the total weight is removed with the skins. Most cooks are agreed that the best results are obtained when they are cooked for a long time, the tubers thus prepared being sweeter and more palatable than those cooked for a short period. In experimental work which has been reported [a] on this subject uniform tubers of medium size were baked for 20, 40, and 60 minutes. Contrary to a common supposition that long baking makes sweet potatoes dry, it was found that those which were baked an hour were in appearance and to the taste moister than those which were baked only 20 minutes, notwithstanding a greater loss in weight in baking. Those which were baked a full hour in the oven were invariably more palatable than the others. In the first 20 minutes of the cooking period the potatoes lost 5.3 per cent in weight, in the second 20 minutes 8.4 per cent, and in the third 20 minutes 11.4 per cent.

The Tuskegee Experiment Station has issued a bulletin, of which G. W. Carver is the author, which summarizes data regarding the cultivation and uses of sweet potatoes and includes a collection of recipes for preparing them for the table. In most cases the recipes deal with methods of serving the sweet potato as a vegetable, though several are given for dishes in which it is combined with meat. Several of the recipes which have to do with the preparation of desserts with sweet potatoes are given below, as perhaps such uses of sweet potatoes are less generally known than the others.

SWEET-POTATO PIE.

For sweet-potato pie the sweet potato should be boiled in the skin. When tender the skin should be removed, the potatoes mashed and beaten until light. To each cup of potato add ½ cup of milk, ½ cup of cream, 2 well-beaten eggs, ¾ teacup of sugar (or a smaller quantity if the potatoes are very sweet), and season with cinnamon and ginger, or other spices, to taste. Bake with a bottom crust only. This quantity is sufficient for 2 or 3 pies.

[a] U. S. Dept. Agr., Farmers' Bul. 129.

A pie may also be made with sliced sweet potatoes which are parboiled until two-thirds done and then sliced lengthwise very thin after removing the skins. The sliced potatoes should be placed in a deep layer in a dish lined with pie crust and sprinkled with ground allspice and a little ginger, cloves, and nutmeg. Before adding the top crust small pieces of butter should be scattered over the potatoes. A teacupful of sugar, ½ teacupful of molasses, and ½ pint of cream should be poured over the pie, small lumps of butter scattered over the top, and the whole dusted sparingly with flour. Then cover with hot water and put on the upper crust and bake in a moderate oven. This pie may be served hot, with or without sauce.

SWEET-POTATO COBBLER.

For sweet potato cobbler, prepare the mashed beaten sweet potatoes as for sweet-potato pie and fill a dish with alternate layers of biscuit dough or some similar crust and sweet potato. The dough should be rolled out quite thin and spread with the sweet-potato mixture in layers about ¼ inch thick. Add to each layer just enough water to give the crust when cooked the consistency of peach or other fruit cobbler crust. Bake until thoroughly done and serve hot with drawn butter or hard sauce.

BAKED SWEET POTATO AND APPLES.

The recipe for sweet potatoes baked with apples is as follows: Wash 4 medium-sized potatoes, peel, and cut the potatoes in slices about ¼ inch thick; pare and slice the same number of apples in the same way. Put the sweet potatoes and apples in a baking dish in alternate layers; sprinkle 1½ cups of sugar over the top, scatter ½ cup of butter also over the top; add ¾ pint of hot water; bake slowly for 1 hour; serve steaming hot.

In some parts of Asia sweet potatoes are preserved in sugar in much the same way as fruits in the United States, and recipes are occasionally found in cookery books for such preserves, lemon and ginger or some similar material being usually employed as a seasoning material.

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